|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Forecast** | **Data source** | **Model type** | **Regional forecasta** | **Ensemble forecast** | **Brief description** |
| 4Sight | ILINet, weather attributes, Google Trends, Healthmap, Wikipedia | Mechanisticb | Yes | Yes | SIRS model with ensemble Kalman filter to assimilate observed data sources. |
| ARETE | ILINet | Statisticalc | Yes | Yes | Historical predictions for part of season, followed by extra trees random forest predictive model. |
| **Columbia 1 - Batman** | **ILINet, Google Extended Health Trends, specific humidity** | **Statistical** | **Yes** | **Yes** | **Weighted average of two statistical forecasting methods based on K-nearest-neighbor and Bayesian model averaging.[1]** |
| **Columbia 2 – Magic 8** | **ILINet, Google Extended Health Trends, specific humidity** | **Both** | **Yes** | **Yes** | **Manual superensemble of other CU methods depending on target.** |
| **Columbia 3 – Puffins** | **ILINet, Google Extended Health Trends, specific humidity** | **Both** | **Yes** | **Yes** | **Bayesian model average of 6 model-inference forecasting variants and 2 statistical forecasting methods.[2]** |
| **Columbia 4 –**  **Vixen** | **ILINet, Google Extended Health Trends, specific humidity** | **Mechanistic** | **Yes** | **Yes** | **Model-inference ensemble forecast using a SEIRS compartmental model coupled with state space estimation and dynamic error growth correction.[3]** |
| **Delphi – Epicast** | **ILINet, crowd-sourced forecasts** | **Statistical** | **Yes** | **Yes** | **Aggregate forecast from many individual crowd-sourced forecasts.[4]** |
| **Delphi – Stat** | **ILINet, Google query volumes, HealthTweets, Wikipedia pageviews, CDC pageviews** | **Statistical** | **Yes** | **Yes** | **Weighted ensemble of several statistical models including empirical Bayes, smoothing splines, empirical distribution.[5]** |
| **FORSEA** | **ILINet, school schedule, weather attributes, Google search results** | **Statistical** | **No** | **Yes** | **Combination of LASSO and random forests to generate point forecasts – probabilities generated from standard error of residuals.** |
| **GHRI** | **Influenza transmission data** | **Mechanistic** | **Yes** | **No** | **SIRS model to estimate lab-confirmed flu cases in each HHS Region, which are then converted to ILINet %.** |
| **Harvard** | **Google search results, EMR data** | **Statistical** | **Yesd** | **No** | **Multivariable regression model dynamically selecting variables for inclusion in forecasting model.[6-9]** |
| **HumNat 1** | **ILINet, air temp, specific humidity** | **Statistical** | **Yes** | **No** | **Use mutual information to explore dependencies between factors including ILI, temperature, specific humidity, then use Random Forest for variable selection, leading to a log-normal generalized linear model.** |
| **HumNat 2** | **ILINet** | **Statistical** | **Yes** | **No** | **Seasonal ARIMA model with fixed autoregressive terms and variable moving average terms across regions.** |
| **ICS** | **ILINet, Twitter** | **Statistical** | **Yes** | **No** | **GLM based on spline functions covering seasonal, mid and short-term history of ILINet and Twitter data.** |
| **ISU** | **ILINet** | **Mechanistic** | **Yes** | **No** | **Bayesian SIR model using information from previous seasons to set priors for the current season** |
| **JL 1** | **ILINet** | **Mechanistic** | **Yes** | **No** | **Fit optimal parabola to current season ILI incidence data, incorporating noise estimated from past seasons.[10]** |
| **JL 2** | **ILINet** | **Mechanistic** | **Yes** | **No** | **Fit optimal flu-specific epidemic curve to current season ILI incidence data, incorporating noise estimated from past seasons.** |
| **KBSI** | **ILINet** | **Statistical** | **Yes** | **Yes** | **Past ILINet values used in support vector machine model to generate point estimates, with probabilities determined from an assumed normal distribution. [11-13]** |
| **KoT - Dev** | **ILINet** | **Statistical** | **Yes** | **Yes** | **Weighted ensemble of 3 models fit to past ILINet data, with model weights changing over the season: kernel density estimation or simple seasonal spline model; kernel conditional density estimation with copulas; and a seasonal ARIMA model.[14, 15]** |
| **KoT - Stable** | **ILINet** | **Statistical** | **Yes** | **Yes** | **Weighted ensemble of 3 models fit to past ILINet data, with model weights changing over the season: truncated kernel density estimation or simple seasonal spline model; kernel conditional density estimation with copulas; and a seasonal ARIMA model.[14, 15]** |
| **LANL** | **ILINet** | **Statistical** | **Yes** | **No** | **Bayesian SIR model using previous seasons to set initial priors, including a reverse random walk discrepancy component to correct end-of-season fit** |
| **NEU** | **ILINet, Twitter** | **Mechanistic** | **Yes** | **No** | **Uses Twitter and ILINet data to set initial conditions for stochastic generative epidemic model, calibrated to historical ILI surveillance.[16, 17]** |
| **PSI** | **ILINet, school vacation schedules, specific humidity** | **Mechanistic** | **Yes** | **No** | **An MCMC procedure with an SIR model using climate and school vacation schedule to determine the reproduction number.  National forecasts are a weighted average of coupled regional forecasts.** |
| **UCSF 1** | **ILINet** | **Statistical** | **Yes** | **No** | **Simple seasonal Holt-Winters forecasting model, with bootstrapped standard errors and a final "pessimization" step reducing certainty** |
| UCSF 2 | ? | ? | Yes | ? | ? |
| **UoM – DSTG** | **ILINet** | **Mechanistic** | **Yes** | **No** | **A bootstrap particle filter method and an SEIR infection model.[18-20]** |
| **Yale 1** | **ILINet, clinical flu surveillance, absolute humidity** | **Mechanistic** | **Yes** | **No** | **Humidity based SIRS model utilizing Bayesian optimization to update prior knowledge with ongoing events. Influenza and non-flu ILI are modeled separately and results are combined for overall predictions.[21]** |
| **Yale 2** | **ILINet** | **Mechanistic** | **Yes** | **No** | **Humidity based SIRS model utilizing Bayesian optimization to update prior knowledge with ongoing events. Influenza and non-flu ILI are modeled as a single outcome.[21]** |

**a**Yes denotes forecast for ≥1 region (for all weeks)

bIncludes models that incorporate compartmental modeling like Susceptible-Exposed-Infected-Recovered [SEIR] models or agent based models

cIncludes models like time series analysis and generalized linear models

dSubmitted regional forecasts for 1 wk ahead targets only

1. Kandula, S., D. Hsu, and J. Shaman, *Subregional Nowcasts of Seasonal Influenza Using Search Trends.* J Med Internet Res, 2017. **19**(11): p. e370.

2. Yamana, T.K., S. Kandula, and J. Shaman, *Individual versus superensemble forecasts of seasonal influenza outbreaks in the United States.* PLoS Comput Biol, 2017. **13**(11): p. e1005801.

3. Pei, S. and J. Shaman, *Counteracting structural errors in ensemble forecast of influenza outbreaks.* Nat Commun, 2017. **8**(1): p. 925.

4. Farrow, D.C., et al., *A human judgment approach to epidemiological forecasting.* PLOS Computational Biology, 2017. **13**(3): p. e1005248.

5. Brooks, L.C., et al., *Flexible Modeling of Epidemics with an Empirical Bayes Framework.* PLoS Comput Biol, 2015. **11**(8): p. e1004382.

6. Santillana, M., et al., *Combining Search, Social Media, and Traditional Data Sources to Improve Influenza Surveillance.* PLoS Comput Biol, 2015. **11**(10): p. e1004513.

7. Santillana, M., et al., *Cloud-based Electronic Health Records for Real-time, Region-specific Influenza Surveillance.* Sci Rep, 2016. **6**: p. 25732.

8. Yang, S., et al., *Using electronic health records and Internet search information for accurate influenza forecasting.* BMC Infect Dis, 2017. **17**(1): p. 332.

9. Yang, S., M. Santillana, and S.C. Kou, *Accurate estimation of influenza epidemics using Google search data via ARGO.* Proc Natl Acad Sci U S A, 2015. **112**(47): p. 14473-8.

10. Lega, J. and H.E. Brown, *Data-driven outbreak forecasting with a simple nonlinear growth model.* Epidemics, 2016. **17**: p. 19-26.

11. Erraguntla, M., et al. *Data Integration and Predictive Analysis System for Disease Prophylaxis*. in *50th Hawaii International Conferense on System Sciences*. 2017. Honolulu, HI.

12. Erraguntla, M., J. Zapletal, and M. Lawley, *Framework for Infectious Disease Analysis: A comprehensive and integrative multi-modeling approach to disease prediction and management.* Health Informatics J, 2017: p. 1460458217747112.

13. Freeze, J., M. Erraguntla, and A. Verma. *Data Integration and Predictive Analysis System for Disease Prophylaxis: Incorporating Dengue Fever Forecasts*. in *51st Hawaii International Conference on System Sciences*. 2018. Honolulu, HI.

14. Ray, E.L. and N.G. Reich, *Prediction of infectious disease epidemics via weighted density ensembles.* PLoS Comput Biol, 2018. **14**(2): p. e1005910.

15. Ray, E.L., et al., *Infectious disease prediction with kernel conditional density estimation.* Stat Med, 2017. **36**(30): p. 4908-4929.

16. Zhang, Q., et al., *Social Data Mining and Seasonal Influenza Forecasts: The FluOutlook Platform*, in *Proceedings, Part III, of the European Conference on Machine Learning and Knowledge Discovery in Databases - Volume 9286*. 2015, Springer-Verlag New York, Inc.: Porto, Portugal. p. 237-240.

17. Zhang, Q., et al., *Forecasting Seasonal Influenza Fusing Digital Indicators and a Mechanistic Disease Model*, in *Proceedings of the 26th International Conference on World Wide Web*. 2017, International World Wide Web Conferences Steering Committee: Perth, Australia. p. 311-319.

18. Moss, R., et al., *Epidemic forecasts as a tool for public health: interpretation and (re)calibration.* Aust N Z J Public Health, 2018. **42**(1): p. 69-76.

19. Moss, R., et al., *Retrospective forecasting of the 2010-2014 Melbourne influenza seasons using multiple surveillance systems.* Epidemiol Infect, 2017. **145**(1): p. 156-169.

20. Zarebski, A.E., et al., *Model selection for seasonal influenza forecasting*. Vol. 2. 2017.

21. Zimmer, C., R. Yaesoubi, and T. Cohen, *A Likelihood Approach for Real-Time Calibration of Stochastic Compartmental Epidemic Models.* PLoS Comput Biol, 2017. **13**(1): p. e1005257.